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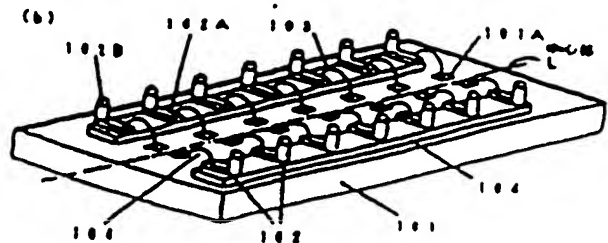
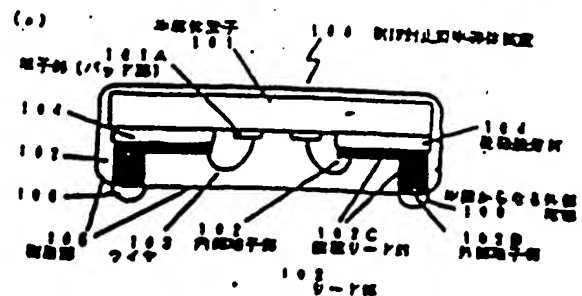
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(17) (発明の名称) 樹脂封止型半導体装置とそれに用いられるリードフレーム、及び樹脂封止型半導体装置の製造方法

(18) (要約)

【目的】 更なる樹脂封止型半導体装置の高集積化、高信頼化が求められている中、半導体装置パッケージサイズにおけるチップの占有率を上げ、半導体装置の小型化に対応させ、同時に従来の T S O P 等の小型パッケージに備えてあった更なる多ピン化を実現した樹脂封止型半導体装置を提供する。

【構成】 半導体素子の端子側の面に、半導体素子の端子と電気的に接続するための内部端子部と、半導体素子の端子側の面へ固定して外部へと向く外部端子部への接続のための外部端子部と、前記内部端子部と外部端子部とを連結する接続リード部とを一体とした装置のリード部とを、絶縁性材料層を介して、固着して設けており、且つ、図解基板等への実装のための本面からなる外部電極を前記装置の各リードの外周端子部に連結させ、少なくとも前記本面からなる外部電極の一部に樹脂部より外部に露出させて設けている。





に従来の T S O P 系の小型パッケージに匹敵するものとなる多ピン化を實現しようとするものである。

( 0 0 0 4 )

( 課題を解決するための手段 ) 本発明の断端封止型半導体装置は、半導体素子の端子側の面に、半導体素子の端子と電気的に接続するための内部端子部と、半導体素子の端子側の面へ突出して外部へと向く外部端子部への接続のための外部端子部と、前記内部端子部と外部端子部とを連結する接続リード部とを一体とした複数のリード部とを、絶縁性材料層を介して、露出して設けており、且つ、図 1 基板上への実装のための半田からなる外部電極を前記複数の各リードの外部端子部に導通させ、少なくとも前記半田からなる外部電極の一部は断端部より外部に突出させて設けていることを特徴とするものである。尚、上記において、内部端子部と外部端子部とを一体とした複数のリード部の配列を半導体素子の端子側面上に二次元的に配列し、外部端子部を半田ボールにて形成することにより B C A ( B o i l C r i d A r r a y ) タイプの断端封止型半導体装置とすることとする。

( 0 0 0 5 ) そして、上記において、半導体素子の端子は半導体素子の端子側の面の一列の辺の略中心部上に設けて配列されており、リード部は複数の端子を挟むように対向し前記一列の辺に沿って設けられていることを特徴とするものである。また、本発明のリードフレームは、断端封止型半導体装置用のリードフレームであって、半導体素子の端子と電気的に接続するための内部端子部と、外部端子部とを連結するための外部端子部と、前記内部端子部と外部端子部とを連結する接続リード部とを一体とし、該外部端子部を、接続リード部を介して、リードフレーム面から突出する一方の側に突出させ、対向し先端部同士で接続部を介して接続する一列の内部端子部を形成設けており、且つ、各外部端子部の外側で、接続リード部と導通し、一体として全体を保持する外側部を設けていることを特徴とするものである。尚、上記リードフレームにおいて、内部端子部と外部端子部とそれらを連結する接続リード部とを一体とした複数のリード部をリードフレーム面に二次元的に配列する形で形成することにより B C A ( B o i l C r i d A r r a y ) タイプの断端封止型半導体装置用のリードフレームとすることとする。

( 0 0 0 6 ) 本発明の断端封止型半導体装置の製造方法は、半導体素子の端子側の面に、半導体素子の端子と電気的に接続するための内部端子部と、半導体素子の端子側の面へ突出して外部へと向く外部端子部への接続のための外部端子部と、前記内部端子部と外部端子部とを連結する接続リード部とを一体とした複数のリード部とを、絶縁性材料層を介して、露出して設けており、且つ、図 1 基板上への実装のための半田からなる外部電極を前記複数の各リードの外部端子部に導通させることとする。

図 1 基板上への実装のための半田からなる外部電極を前記複数の各リードの外部端子部に導通させることとする。また、上記において、半導体素子の端子は半導体素子の端子側の面の一列の辺の略中心部上に設けて配列されており、リード部は複数の端子を挟むように対向し前記一列の辺に沿って設けられていることを特徴とするものである。また、本発明のリードフレームは、断端封止型半導体装置用のリードフレームであって、半導体素子の端子と電気的に接続するための内部端子部と、外部端子部とを連結するための外部端子部と、前記内部端子部と外部端子部とを連結する接続リード部とを一体とし、該外部端子部を、接続リード部を介して、リードフレーム面から突出する一方の側に突出させ、対向し先端部同士で接続部を介して接続する一列の内部端子部を形成設けており、且つ、各外部端子部の外側で、接続リード部と導通し、一体として全体を保持する外側部を設けていることを特徴とするものである。尚、上記リードフレームにおいて、内部端子部と外部端子部とそれらを連結する接続リード部とを一体とした複数のリード部をリードフレーム面に二次元的に配列する形で形成することにより B C A ( B o i l C r i d A r r a y ) タイプの断端封止型半導体装置用のリードフレームとすることとする。

( 0 0 0 7 )

( 作用 ) 本発明の断端封止型半導体装置は、上記のような構成にすることにより、半導体装置パッケージサイズにおけるチップの占有量を上げ、半導体装置の小型化に対応できるものとしている。即ち、半導体装置の図 1 基板への実装部を低減し、図 1 基板上への実装部の向上を可能としている。詳しくは、内部端子部、外部端子部とを一体とした複数のリード部を半導体素子面に絶縁性材料層を介して露出し、前記外部端子部に半田からなる外部電極を導通させていることにより、装置の小型化を達成している。そして、上記半田からなる外部電極を、半導体素子面に略等間隔で二次元的に配列することにより、半導体装置の多ピン化を可能としている。半田からなる外部電極を半田ボールとし、二次元的に該外部電極部を配列した場合には B C A タイプとなり、半導体装置の多ピン化にも対応できる。また、上記において、半導体素子の端子が半導体素子の端子側の面の一列の辺の略中心部上に設けて配列され、リード部は複数の端子を挟むように対向し前記一列の辺に沿って設けられており、簡単な構造とし、生産性に優れた構造としている。本発明のリードフレームは、上記のような構成にすることにより、上記断端封止型半導体装置の製造を可能とするものであるが、従来のリードフレームと同様のエッチ

とがてき、本発明の絶縁防止型半導体装置の製造方法は、上記リードフレームを用いて、リードフレームの外装端子部側でない面（裏面）に地線材を付け、打ち金は合金により、方向する内部端子部側を形成する導線部と導線部に対応する位置に設けられた地線材とを打ち金し、リードフレームの打ち金された部分が半導体素子の端子部にくるようにして、前記導線材を介して、リードフレーム全体を半導体素子へ搭載し、リードフレームの外装部を含む不要の部分を打ち金と合金により切断することにより、内部端子と外部端子を一体とした組み立て半導体装置上に搭載した。本発明の、半導体装置の小型化が可能、且つ、多ピン化が可能な絶縁防止型半導体装置の作用を可能としている。

(0008)

(実施例) 本発明の絶縁防止型半導体装置の実施例を以下、図にそって説明する。図1(a)は本実施例の絶縁防止型半導体装置の断面図であり、図1(b)は裏面の図である。図1中、100は絶縁防止型半導体装置、101は半導体素子、102はリード部、102Aは内部端子部、102Bは外部端子部、102Cは形成リード部、101Aは端子部（パッド部）、103はワイヤ、104は地線層材料、105は導線部、106は半田（ペースト）からなる外部電極である。本実施例の絶縁防止型半導体装置は、前述するリードフレームを用いたもので、内部端子部102A、外部端子部102Bを一体とした十字型のリード部102を多数半導体素子101上に地線層材料104を介して搭載し、且つ、外部端子部102B先に半田からなる外部電極を形成部105より外部へ突出させて設けた。パッケージ筐体が半導体装置の面側に接する絶縁防止型半導体装置であり、図1(a)へ搭載される際には、半田（ペースト）を溶解、固化して、外部端子部102Bが外部電極と電気的に接続される。本実施例の絶縁防止型半導体装置は、図1(b)に示すように、半導体素子101の端子部（パッド部）101Aは半導体素子の中心部とほぼ対向して2箇所、中心部に沿って配置されており、リード部102は、内部端子部102Aが前記端子部（パッド部）に接した位置に半導体素子101の面の外側に中心部を挟み対向するように配置されている。外部端子部102Bは内部端子部102Aから形成リード部102Cを介して形成され、ほぼ半導体素子の側面までに達した位置で半導体素子面に傾斜する方向に、形成リード部102Cが十字に曲がり、外部端子部102Bはその先端に位置し、半導体素子の面にほぼ対向して二次元的に配置している。即ち、中心部とほぼ2列の外装端子部102Bの配列を設けている。そして、各外部端子部102Bを形成部105より外部に突出させて設けている。1. 地線層材料104としては、100μm厚のポリイ

と酸を用いたが、他には、シリコンエポキシイミド1TA1715（住友ヘラクライト株式会社）や絶縁化型導線部HCG5200（住友電線株式会社）等が用いられる。上記実施例では、半田ペーストからなる外部電極であるが、この部分は半田ボールに代えても良い。尚、本実施例の絶縁防止型半導体装置は、上記のように、パッケージ筐体が半導体装置の面側に接する、面側に小型化されたパッケージであるが、厚み方向について、41.0mm以下にすることができ、厚みも同様に薄くしてよいのである。本実施例においては外部電極部を、半導体素子の端子部（パッド部）に約2列に配列したが、半導体素子の端子部の位置を二次元的に配置し、内部端子部と外部端子部とを一体となった組み立て半導体素子の端子部側に二次元的に配列して搭載することにより、半導体素子の、一層の多ピン化に十分対応できる。

(0009) 次に、本発明のリードフレームの実施例を、図に示して説明する。本実施例のリードフレームは、上記実施例の半導体装置に用いられたものである。図2は本実施例のリードフレームの平面図を示すもので、図2中、200はリードフレーム、201は内部端子部、202は外部端子部、203は形成リード部、204は導線部、205は外部電極である。リードフレームは42合金（Ni42%のFe合金）からなり、リードフレームの厚さは、内部端子部のある側面部で0.05mm、外部端子部のある側面部で0.2mmである。内部端子部の方向する先端部側と導線部205も厚肉（0.05mm厚）に形成されており、前述する半導体装置を形成する際の打ち金は合金にて打ち金とし、良い接続となっている。本実施例では外部端子部202は丸状であるが、これに限定されない。また、リードフレーム材料として42合金を用いたがこれに限定されない。48合金でも良い。

(0010) 次に、上記実施例のリードフレームの製造方法を図を用いて図3に説明する。図4は本実施例のリードフレームを製造した工程を示したものである。先ず、42合金（Ni42%のFe合金）からなる、厚さ0.2mmのリードフレーム原料300を準備し、図の両面を研磨を行い丸く成形処理した（図3(a)）は、リードフレーム原料300の両面に感光性のレジスト301を塗布し、乾燥した。（図3(b)）。次いで、リードフレーム原料300の両面から所定のパターン部を用いてレジストの所定の部分のみに露光を行った後、露光処理し、レジストパターン301Aを形成した。（図3(c)）

露光レジストとしては東京化成株式会社のネガ型露光レジスト（PMEKレジスト）を使用した。次いで、レジストパターン301Aを剥離処理として、57°C、48ボームの塩化第二水素溶液にて、リードフレーム原料300の両面からスブレイエッチングして、外部電極

の平面図が図2に示され、リードフレームを付設した(図3(c))。図2(b)のは、図2(a)のA1-A2における断面図である。この際、レジストを剥離した後、洗浄処理を施した後、所定の箇所(内部端子部分を含む領域)のみに金メッキ処理を行った。(図3(e))尚、上記リードフレームの製造工程においては、図2(b)に示すように、厚肉部と薄肉部を形成するため、外部端子形成面側からのエッチング(露出)を多く行い、反対面側からは少なめにエッチング(露出)を行った。また、金メッキに代え、銀メッキやパラジウムメッキでも良い。上記のリードフレームの製造方法は、1枚の半導体装置を製作するために必要なリードフレーム1枚の製造方法であるが、通常は多数性の面から、リードフレーム素材をエッチング加工する時、図2に示すリードフレームを複数面付けした状態で作成し、上記の工程を行う。この場合は、図2に示す外部部205の一部に導通する肉部(図示していない)をリードフレームの外側に付けて延付け状態とする。

(0011)次に、上記のようにして作成されたリードフレームを用いた、本発明の密封型半導体装置の製造方法の実施例を図にそって説明する。図4は、本実施例の密封型半導体装置の製造工程を示すものである。図3に示すようにして作成されたリードフレーム400の外部端子部402形成面(裏面)と対向する裏面に、ポリイミド系熱硬化型の絶縁性材料(テープ)401(日立化成株式会社製、HM122C)を、400°C、6Kg/m<sup>2</sup>で1.0秒熱圧着して貼りつけた(図4(a))。この状態の平面図を図5に示す。この後、打ち抜き金型405A、405Bにて(図4(b))、対向する内部端子部の先端部を導通する導通部403と、その部分の絶縁性材料(テープ)401とを打ち抜いた。(図4(c))

次いで、外側打ち抜きおよび圧着金型406A、406Bを用い、外側部404を含む不要の部分を取り除く(図4(d))と同時に、絶縁性材料404を介して半導体素子407上にリード部408の熱圧着を行った。(図4(e))

尚、この図4(d)に示す、作成リードと導通してリードフレーム全体を支えている外部部204を含む不要の部分を取り除きは、密封防止には行っても良い。この場合には、通常の半導体リードフレームを用いたQFPパッケージ等のようにダムバー(図示していない)を設けると良い。リード部410を半導体素子411へ接続した後、ワイヤ414により、半導体素子の端子(パッド)411Aとリード部410の内部端子410Aとを電気的に結集した。(図4(f))

その後、所定の金型を用い、エポキシ系の樹脂415でリード部410の外部端子部410Bのみを固定させ、全体を封止した。(図4(g))

ここでは、両面の金型(図示していない)を用いたが、

所定の面(外部端子部)を封止し封止してきただけで、エッチングに必要としない。次いで、図4に示されている外部端子部410B上に半導体ペーストをスクリーン印刷により塗布し、半田(ペースト)からなる外部端子部416を形成し、本発明の密封型半導体装置を完成させた。(図4(h))

尚、半田からなる外部端子部416の形成は、スクリーン印刷に限定されるものではなく、リフローまたはポッティング等でも、図4(b)と半田は露出との形成に必要ない半田が得られれば良い。

(0012)

(発明の効果)本発明は、上記のように、更なる密封防止型半導体装置の高集積化、高信頼化が求められる状況のもと、半導体装置パッケージサイズにおけるチップの占有部を上げ、半導体装置の小型化に対応させ、図4(b)への実装面側を露出させる、即ち、図4(b)への実装面側を向上させることができる半導体装置の提供を可能としたものであり、同時に従来のTSOP等の小型パッケージに図4に示した更なる多ピン化を実現した密封防止型半導体装置の提供を可能としたものである。

(図面の簡単な説明)

(図1) 実施例の密封型半導体装置の概略断面図及び裏面図

(図2) 実施例のリードフレームの平面図

(図3) 実施例のリードフレームの製造工程図

(図4) 実施例の密封型半導体装置の製造工程図

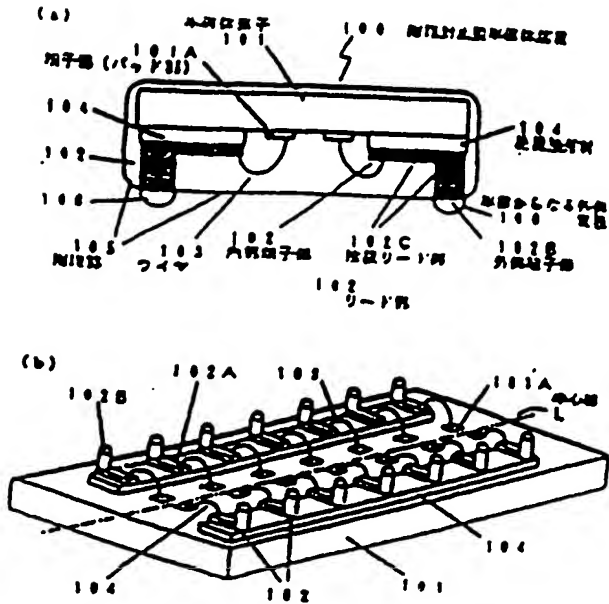
(図5) 実施例のリードフレームに絶縁性材料を貼りつけた状態の平面図

(符号の説明)

100	密封型半導体装置
101	半導体素子
101A	端子部(パッド部)
102	リード部
102A	内部端子部
102B	外部端子部
102C	作成リード部
103	ワイヤ
104	絶縁性材料
105	樹脂部
106	半田(ペースト)からなる外部
200	リードフレーム
201	内部端子部
202	外部端子部
203	作成リード部
204	導通部
205	外側部
300	リードフレーム素材
301	レジスト

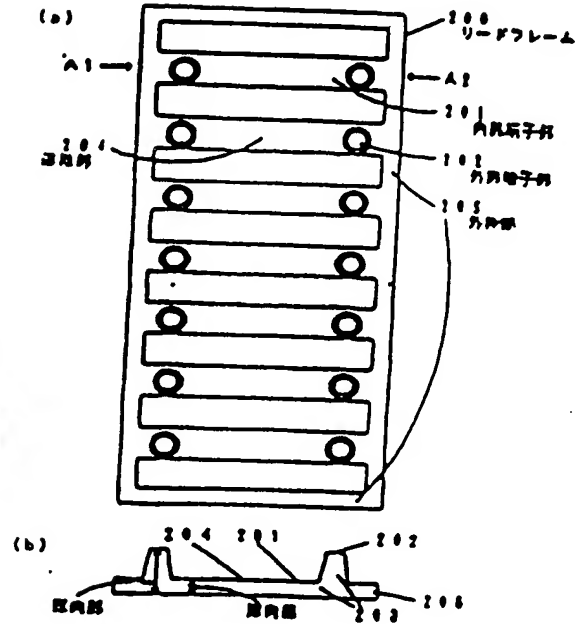
303A	内装端子部
303B	外装端子部
304	通孔部
305	金メッキ部
306	穴部
400	リードフレーム
401	絶縁性基材 (テープ)
402	外装端子部
403	通孔部

( 図 1 )

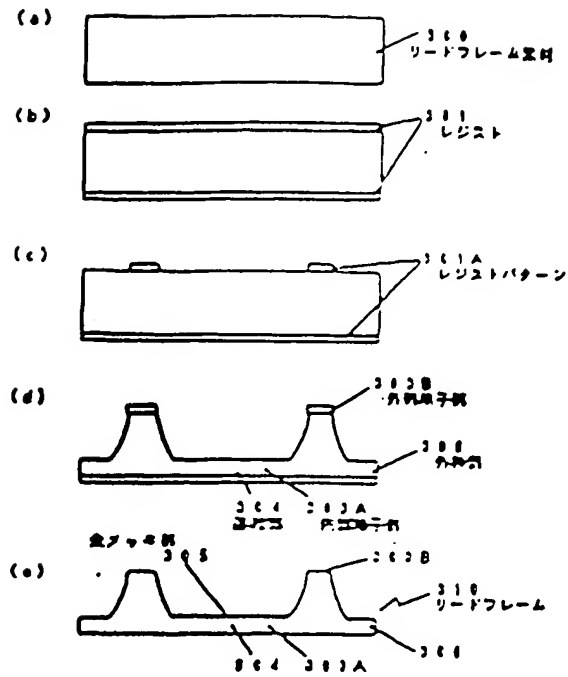


405A, 405B	17ちび金型
406A, 406B	穴の17ちびおよび区本用金型
410	リード部
410A	内装端子部
410B	外装端子部
410C	接続リード部
411	半導体素子
411A	ワイヤ
415	板部

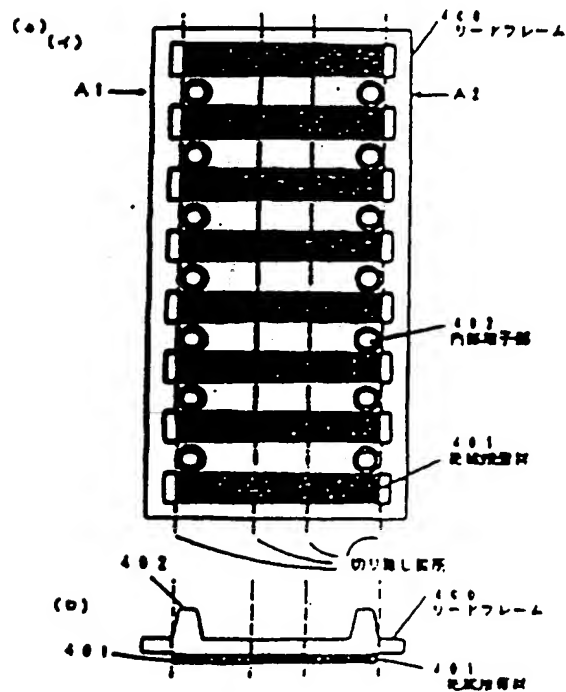
( 図 2 )



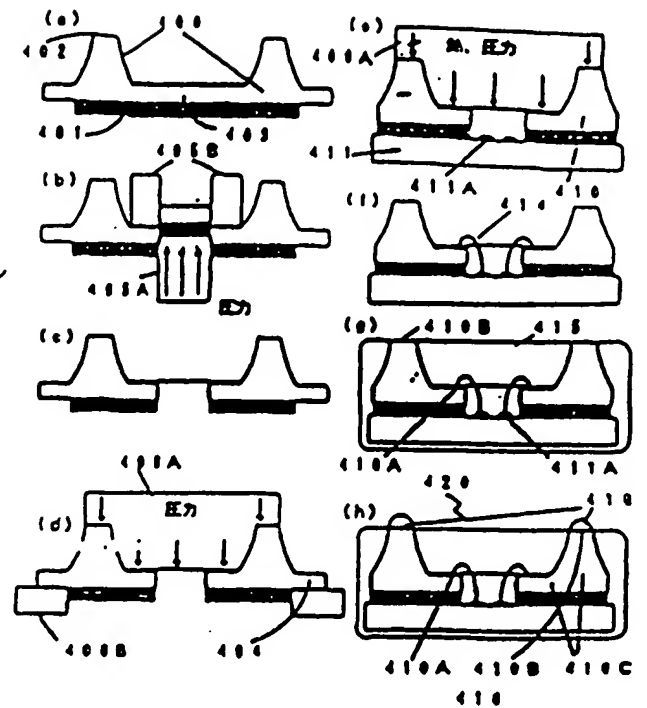
11



( 5 )



(B 4)





## Japanese Patent Laid-Open Publication No. Heisei 8-125066

## [TITLE OF THE INVENTION]

Resin Encapsulated Semiconductor Device , Lead Frame  
5 Used Therein, and Fabrication Method for the Resin  
Encapsulated Semiconductor Device

## [CLAIMS]

1. A resin encapsulated semiconductor device  
10 comprising:

a semiconductor chip;

a plurality of leads fixedly attached to a terminal-  
end surface of the semiconductor chip by an insulating  
adhesive interposed between the semiconductor chip and the  
15 leads, each of the leads including integral portions, that  
is, an inner terminal portion adapted to be electrically  
connected to an associated one of terminals of the  
semiconductor chip, an outer terminal portion extending  
outwardly in a direction orthogonal to the terminal-end  
20 surface of the semiconductor chip and adapted to be  
connected to an external circuit, and a connecting lead  
portion adapted to connect the inner and outer terminal  
portions to each other; and

outer electrodes each connected to the outer terminal  
25 portion of an associated one of the leads and made of

solder to allow the semiconductor device to be mounted on a circuit board, at least a part of the outer leads being externally exposed from a resin encapsulate.

5           2. The resin encapsulated semiconductor device according to claim 1, wherein the terminals of the semiconductor chip are arranged along a substantially center line between a pair of sides of the semiconductor chip on the terminal-end surface of the semiconductor chip,  
10       and the leads are arranged in two facing sets along the sides of the semiconductor chip, respectively, in such a fashion that the terminals of the semiconductor chip are interposed between the two facing lead sets.

15           3. A lead frame comprising:

          a plurality of leads each including integral portions, that is, an inner terminal portion adapted to be electrically connected to an associated one of terminals of a semiconductor chip, an outer terminal portion adapted to  
20       be connected to an associated one of terminals of an external circuit, and a connecting lead portion adapted to connect the inner and outer terminal portions to each other;

          each of the outer terminal portions of the leads  
25       being protruded in a direction orthogonal to a lead frame

surface via an associated one of the connecting lead portions;

the inner lead portions of the leads being arranged in pair in such a fashion that the leads of each lead pair have facing tips, respectively;

connecting portions each adapted to connect the facing tips of the leads included in an associated one of the lead pairs; and

an outer frame portion arranged outside the outer terminal portions and connected to the connecting lead portions in such a fashion that they form an integral structure together, thereby protecting the entire portion of the lead frame.

4. A method for fabricating a semiconductor device including a semiconductor chip, a plurality of leads fixedly attached to a terminal-end surface of the semiconductor chip by an insulating adhesive-interposed between the semiconductor chip and the leads, each of the leads including integral portions, that is, an inner terminal portion adapted to be electrically connected to an associated one of terminals of the semiconductor chip, an outer terminal portion extending outwardly in a direction orthogonal to the terminal-end surface of the semiconductor chip and adapted to be connected to an external circuit,

and a connecting lead portion adapted to connect the inner and outer terminal portions to each other; and outer electrodes each connected to the outer terminal portion of an associated one of the leads and made of solder to allow  
5 the semiconductor device to be mounted on a circuit board, at least a part of the outer leads being externally exposed from a resin encapsulate, comprising the steps of:

(A) fabricating a lead frame including a plurality of leads each including integral portions, that is, an inner  
10 terminal portion adapted to be electrically connected to an associated one of terminals of a semiconductor chip, an outer terminal portion adapted to be connected to an associated one of terminals of an external circuit, and a connecting lead portion adapted to connect the inner and  
15 outer terminal portions to each other, each of the outer terminal portions of the leads being protruded in a direction orthogonal to a lead frame surface via an associated one of the connecting lead portions, the inner lead portions of the leads being arranged in pair in such a  
20 fashion that the leads of each lead pair have facing tips, respectively, connecting portions each adapted to connect the facing tips of the leads included in an associated one of the lead pairs, and an outer frame portion arranged outside the outer terminal portions and connected to the  
25 connecting lead portions in such a fashion that they form

an integral structure together, thereby protecting the entire portion of the lead frame;

(B) applying an insulating layer to a surface of the lead frame opposite to the outer terminal portions, punching out the connecting portions adapted to connect facing ones of the inner lead portions to each other along with portions of the insulating layer respectively arranged at regions corresponding to the connecting portions by use of punching dies, aligning the punched portions of the lead frame with the terminals of the semiconductor chip, and mounting the entire portion of the lead frame on the semiconductor chip by the adhesive interposed therebetween;

(C) cutting off unnecessary portions of the lead frame including the outer frame portion by use of punching dies, thereby removing the cut-off portions;

(D) wire-bonding the terminals of the semiconductor chip with tips of the inner terminal portions mounted on the semiconductor chip, and encapsulating the semiconductor chip and the lead frame by a resin while allowing a surface of the lead frame toward the outer terminal portions to be externally exposed; and

(E) forming outer electrodes made of solder on the exposed lead frame surface toward the outer terminal portions.

[DETAILED DESCRIPTION OF THE INVENTION]

[FIELD OF THE INVENTION]

The present invention relates to a resin encapsulated semiconductor device (plastic package) in which a semiconductor chip is packaged, and more particularly to a semiconductor device configured to achieve an improvement in mounting density or to have a multi-pinned structure and a method for manufacturing such a semiconductor device.

10 [DESCRIPTION OF THE PRIOR ART]

Recently, semiconductor devices have been developed to have a higher integration degree and a higher performance by virtue of developments of techniques associated with an increase in integration degree and miniaturization and in pace with the tendency of electronic appliances to have a high performance and a light, thin, simple, and miniature structure. A representative example of such semiconductor devices is an ASIC of LSI. For instance, developments of resin encapsulated semiconductor device plastic packages have been advanced from surface-mounting packages such as SOJs (Small Outlined-Leaded Packages) or QFPs (Quad Flat Packages) to packages having a miniature structure mainly achieved in accordance with a thinness obtained by virtue of developments of TSOPs (Thin Small Outline Packages) or to LOC (Lead On Chip) structures

adapted to achieve an improvement in the chip packaging efficiency by virtue of developments of an internal three-dimensional package structure. In addition to an increase in integration degree and improvement in performance, there has also been growing demand for an increase in the number of pins, thickness, and miniaturization of resin encapsulated semiconductor packages. In the above mentioned conventional packages, however, there is a limitation in miniaturization because those packages have a structure in which leads are arranged around a chip. Similarly, leads are arranged around a chip in the case of miniature packages such as TSOPs. In such packages, there is also a limitation in increasing the number of pins due to the pin pitch used.

[SUBJECT MATTERS TO BE SOLVED BY THE INVENTION]

As mentioned above, there has been demand for an increase in integration degree and improvement in performance of resin encapsulated semiconductor devices. Also, there has also been growing demand for an increase in the number of pins, thickness, and miniaturization of resin encapsulated semiconductor packages. In such situations, the present invention makes it possible to increase the occupancy degree of a chip in a semiconductor package with a limited size while reducing the mounting area of the

semiconductor package on a circuit board to achieve a  
miniaturization of the resulting semiconductor device.  
That is, the present invention is adapted to provide a  
resin encapsulated semiconductor device capable of  
5 achieving an improvement in the mounting density thereof on  
a circuit board. Also, the present invention is adapted to  
achieve an increase in the number of pins which is  
difficult in miniature packages such as conventional TSOPs.

10 [MEANS FOR SOLVING THE SUBJECT MATTERS]

The resin encapsulated semiconductor device of the  
present invention is characterized in that it comprises: a  
semiconductor chip; a plurality of leads fixedly attached  
to a terminal-end surface of the semiconductor chip by an  
15 insulating adhesive interposed between the semiconductor  
chip and the leads, each of the leads including integral  
portions, that is, an inner terminal portion adapted to be  
electrically connected to an associated one of terminals of  
the semiconductor chip, an outer terminal portion extending  
20 outwardly in a direction orthogonal to the terminal-end  
surface of the semiconductor chip and adapted to be  
connected to an external circuit, and a connecting lead  
portion adapted to connect the inner and outer terminal  
portions to each other; and outer electrodes each connected  
25 to the outer terminal portion of an associated one of the



leads and made of solder to allow the semiconductor device to be mounted on a circuit board, at least a part of the outer leads being externally exposed from a resin encapsulate. The above semiconductor device can be embodied into a BGA (Ball Grid Array) type resin encapsulated semiconductor device by arranging a plurality of leads each having an inner terminal portion and an outer terminal portion integral with each other in a two-dimensional fashion on the terminal-end surface of the semiconductor chip and forming the outer electrodes in the form of solder balls.

The above semiconductor device is also characterized in that the terminals of the semiconductor chip are arranged along a substantially center line between a pair of sides of the semiconductor chip on the terminal-end surface of the semiconductor chip, and the leads are arranged in two facing sets along the sides of the semiconductor chip, respectively, in such a fashion that the terminals of the semiconductor chip are interposed between the two facing lead sets. The lead frame of the present invention is characterized in that it comprises: a plurality of leads each including integral portions, that is, an inner terminal portion adapted to be electrically connected to an associated one of terminals of a semiconductor chip, an outer terminal portion adapted to be

connected to an associated one of the terminals of an external circuit, and a connecting lead portion adapted to connect the inner and outer terminal portions to each other; each of the outer terminal portions of the leads being protruded in a direction orthogonal to a lead frame surface via an associated one of the connecting lead portions; the inner lead portions of the leads being arranged in pair in such a fashion that the leads of each lead pair have facing tips, respectively; connecting portions each adapted to connect the facing tips of the leads included in an associated one of the lead pairs; and an outer frame portion arranged outside the outer terminal portions and connected to the connecting lead portions in such a fashion that they form an integral structure together, thereby protecting the entire portion of the lead frame. The above lead frame can be embodied into a lead frame for a BGA (Ball Grid Array) type resin encapsulated semiconductor device by arranging a plurality of leads each having an inner terminal portion and an outer terminal portion integral with each other in a two-dimensional fashion on the terminal-end surface of the semiconductor chip and forming the outer electrodes in the form of solder balls.

The present invention is also characterized by a method for fabricating a semiconductor device including a semiconductor chip, a plurality of leads fixedly attached

to a terminal-end surface of the semiconductor chip by an insulating adhesive interposed between the semiconductor chip and the leads, each of the leads including integral portions, that is, an inner terminal portion adapted to be electrically connected to an associated one of terminals of the semiconductor chip, an outer terminal portion extending outwardly in a direction orthogonal to the terminal-end surface of the semiconductor chip and adapted to be connected to an external circuit, and a connecting lead portion adapted to connect the inner and outer terminal portions to each other; and outer electrodes each connected to the outer terminal portion of an associated one of the leads and made of solder to allow the semiconductor device to be mounted on a circuit board, at least a part of the outer leads being externally exposed from a resin encapsulate, comprising the steps of: (A) fabricating a lead frame including a plurality of leads each including integral portions, that is, an inner terminal portion adapted to be electrically connected to an associated one of terminals of a semiconductor chip, an outer terminal portion adapted to be connected to an associated one of terminals of an external circuit, and a connecting lead portion adapted to connect the inner and outer terminal portions to each other, each of the outer terminal portions of the leads being protruded in a direction orthogonal to a

1 ad frame surface via an associated one of the connecting  
lead portions, the inner lead portions of the leads being  
arranged in pair in such a fashion that the leads of each  
lead pair have facing tips, respectively, connecting  
5 portions each adapted to connect the facing tips of the  
leads included in an associated one of the lead pairs, and  
an outer frame portion arranged outside the outer terminal  
portions and connected to the connecting lead portions in  
such a fashion that they form an integral structure  
10 together, thereby protecting the entire portion of the lead  
frame; (B) applying an insulating layer to a surface of the  
lead frame opposite to the outer terminal portions,  
punching out the connecting portions adapted to connect  
facing ones of the inner lead portions to each other along  
15 with portions of the insulating layer respectively arranged  
at regions corresponding to the connecting portions by use  
of punching dies, aligning the punched portions of the lead  
frame with the terminals of the semiconductor chip, and  
mounting the entire portion of the lead frame on the  
20 semiconductor chip by the adhesive interposed therebetween;  
(C) cutting off unnecessary portions of the lead frame  
including the outer frame portion by use of punching dies,  
thereby removing the cut-off portions; (D) wire-bonding the  
terminals of the semiconductor chip with tips of the inner  
25 terminal portions mounted on the semiconductor chip, and

encapsulating the semiconductor chip and the lead frame by  
a resin while allowing a surface of the lead frame toward  
the outer terminal portions to be externally exposed; and  
(E) forming outer electrodes made of solder on the exposed  
5 lead frame surface toward the outer terminal portions.

#### [FUNCTIONS]

With the above mentioned configuration, the resin  
encapsulated semiconductor device of the present invention  
10 can increase the occupancy degree of the chip while  
achieving a miniaturization thereof. That is, the resin  
encapsulated semiconductor device is capable of reducing  
the mounting area thereof on a circuit board and achieving  
an improvement in the mounting density thereof on the  
15 circuit board. In particular, the present invention  
achieves a miniaturization of the semiconductor device by  
fixedly attaching a plurality of leads each including an  
inner terminal portion and an outer terminal portion  
integral with each other to a surface of a semiconductor  
20 chip by an insulating adhesive layer interposed between the  
semiconductor chip and the leads, and connecting outer  
electrodes made of solder to the outer terminal portions,  
respectively. Also, the present invention achieves an  
increase in the number of pins in the semiconductor device  
25 by arranging the outer electrodes made of solder in a two-

dimensional fashion on a plane parallel to the surface of the semiconductor chip. Where the outer electrodes made of solder are formed in the form of solder balls and arranged in a two-dimensional fashion, a BGA type semiconductor device capable of achieving an increase in the number of pins can be obtained. In the above semiconductor device, the terminals of the semiconductor chip are arranged along a substantially center line between a pair of sides of the semiconductor chip on the terminal-end surface of the semiconductor chip, and the leads are arranged in two facing sets along the sides of the semiconductor chip, respectively, in such a fashion that the terminals of the semiconductor chip are interposed between the two facing lead sets. Thus, the semiconductor device has a simple structure suitable in regard to productivity. The lead frame of the present invention makes it possible to fabricate the above mentioned resin encapsulated semiconductor device by virtue of the above mentioned configuration thereof. However, this lead frame can be fabricated using a half etching method during an etching process as used for conventional lead frames. The method for fabricating a resin encapsulated semiconductor device in accordance with the present invention involves the steps of applying an insulating layer to a surface of the lead frame opposite to the outer terminal portions, punching out

the connecting portions adapted to connect facing ones of the inner lead portions to each other along with portions of the insulating layer respectively arranged at regions corresponding to the connecting portions by use of punching dies, aligning the punched portions of the lead frame with the terminals of the semiconductor chip, and mounting the entire portion of the lead frame on the semiconductor chip by the adhesive interposed therebetween, and cutting off unnecessary portions of the lead frame including the outer frame portion by use of punching dies, thereby removing the cut-off portions. Thus, a plurality of leads each including an inner terminal portion and an outer terminal portion integral with each other are mounted on a semiconductor chip. Accordingly, the present invention makes it possible to achieve a miniaturization of semiconductor devices. In accordance with the present invention, it is also possible to fabricate a resin encapsulated semiconductor device having an increased number of pins.

#### [EMBODIMENTS]

Hereinafter, embodiments of the present invention associated with resin encapsulated semiconductor devices will be described in conjunction with the annexed drawings.

Fig. 1A is a cross-sectional view schematically

illustrating a resin encapsulated semiconductor device according to an embodiment of the present invention. Fig. 1B is a perspective view illustrating an essential part of the resin encapsulated semiconductor device. Figs. 1A and 5 1B, the reference numeral 100 denotes the resin encapsulated semiconductor device, 101 a semiconductor chip, 102 leads, 102A inner terminal portions, 102B outer terminal portions, 102C connecting lead portions, 101A contacts (pads), 103 wires, 104 an insulating adhesive, 105 a resin encapsulate, 106 outer electrodes made of solder (paste), respectively. The resin encapsulated semiconductor device according to this embodiment is fabricated using a lead frame which will be described hereinafter. In this resin encapsulated semiconductor device, a plurality of L-shaped leads 102, each of which 15 has an inner terminal portion 102A and an outer terminal portion 102 integral with each other, are mounted on a semiconductor chip 101 by means of an insulating adhesive 104. An outer electrode 106, which is made of solder, is 20 attached to each outer terminal portion 102B. The outer electrode 106 is outwardly protruded from a resin encapsulate 105. The resin encapsulated semiconductor device configured as mentioned above has a package area substantially equal to the entire area thereof. When this 25 semiconductor device is mounted on a circuit board, the



solder is melted and then solidified to allow the outer terminal portions 102B to be electrically connected to an external circuit. In the resin encapsulated semiconductor device according to the illustrated embodiment, contacts (pads) 101A provided at the semiconductor chip 101 are arranged in pairs along a center line L of the semiconductor chip 101 at opposite sides of the center line L in such a fashion that contacts included in each contact pair face each other. The outer terminal portion 102B of each lead is spaced apart from the inner terminal portion 102A of the lead. Between the inner and outer terminal portions 102A and 102B, a connecting lead portion 102C is interposed. The connecting lead portion 102C of each lead is bent in a direction orthogonal to the major surface of the semiconductor chip at a position near an associated one of the side surfaces of the semiconductor chip 101, so that it has an L shape. In each lead, the outer terminal portion 102B is arranged at an end of the connecting lead portion 102C. The outer terminal portions 102B of the leads are arranged in a one-dimensional fashion on a plane parallel to the major surface of the semiconductor chip 101. That is, the outer terminal portions 102B are arranged in two lines at opposite sides of the center line L. As mentioned above, one outer electrode 106 made of solder is connected to the outer terminal portion 102B of

each lead and outwardly exposed from the resin encapsulate  
105.

For the insulating adhesive 104, a polyimide-based thermoplastic adhesive having a thickness of 100  $\mu$ m (HM122C  
5 manufactured by Hitachi Chemical Co., Ltd.) is preferably used. Alternatively, a silicon denaturalized polyimide adhesive (ITA1715 manufactured by Sumitomo Bakelite Co., Ltd.) or a thermosetting adhesive (HG5200 manufactured by Tomoekawa Papermaking Co., Ltd.) may be used. Although  
10 outer electrodes made of solder paste are used in the illustrated embodiment, solder balls may be used.

As mentioned above, the resin encapsulated semiconductor device according to the illustrated embodiment has a package area substantially equal to the  
15 entire area thereof. That is, the illustrated embodiment of the present invention provides a package having a compact structure in regard to area. In accordance with the present invention, a thinned package structure can also be provided in that it is also possible to reduce the  
20 package thickness to about 1.0 mm or less. Although the outer electrodes have been described as being arranged in two lines along the contacts (pads) of the semiconductor chip, they may be arranged in a two-dimensional fashion. This is achieved by arranging contacts of the semiconductor  
25 chip in a two-dimensional fashion. On the surface of the

semiconductor chip arranged with those contacts, a plurality of terminal sets each having an inner terminal and outer terminal integral with each other are arranged in a two-dimensional fashion. In this case, it is possible to fabricate a semiconductor device using a semiconductor chip with an increased number of pins.

An embodiment of the present invention associated with a lead frame will now be described. The lead frame according to this embodiment is adapted to be used in the above mentioned semiconductor device. Fig. 2 is a plan view of the lead frame according to this embodiment. In Fig. 2, the reference numeral 200 denotes a lead frame, 201 inner terminal portions, 202 outer terminal portions, 203 connecting lead portions, 204 a connecting portion, and 205 an outer frame portion, respectively. The lead frame is made of 42 ALLOY (namely, an Fe alloy containing 42% Ni). The lead frame has a thickness of 0.05 mm at its thinner portion, that is, the inner terminal portions, and a thickness of 0.2 mm at its thicker portion, that is, the outer terminal portions. The connecting portion, which connects facing tips of the inner terminal portions to each other, has a thickness of 0.05 mm corresponding to that of the thinner portion. This connecting portion has a structure capable of allowing an easy punching thereof in the fabrication of the semiconductor device, as described

hereinafter. Although the outer terminal portions 202 have a ball shape in the illustrated embodiment, they are not limited to this shape. Also, although the lead frame has been described as being made of the 42 ALLOY, it is not  
5 limited to this material. For the lead frame, a copper-based alloy may be used.

Now, fabrication of the lead frame according to the illustrated embodiment will be described in brief. Fig. 4 illustrates a process for fabricating the lead frame  
10 according to the illustrated embodiment. First, a lead frame blank 300 having a thickness of 0.2 mm was prepared which is made of a 42 ALLOY (an Fe alloy containing 42% Ni). The prepared lead frame blank 300 was then subjected to a cleaning process, thereby removing grease from the  
15 surfaces thereof (Fig. 3a). Subsequently, photoresist films 301 were coated over both surfaces of the lead frame blank 300, respectively. The coated photoresist films 301 were then dried (Fig. 3b).

Using desired pattern plates, the photoresist films  
20 301 on both surfaces of the lead frame blank 300 were exposed to light at their desired portions. A developing process was then conducted to the light-exposed photoresist films 301, thereby forming photoresist patterns 301A.

For the photoreist films, a negative liquid-phase  
25 resist (PMER resist) manufactured by Tokyo Ohka Co., Ltd.

was used. Using the resist patterns 301A as anti-etch films, the lead frame blank 300 was subjected to a spray etching process at both surfaces thereof. The spray etching process was conducted using a ferric chloride solution of 48 BAUME at 57 °C. Thus, a lead frame having a structure of Fig. 2a was obtained (Fig. 3d). Fig. 2a is a plan view of the lead frame. Fig. 2b is a cross-sectional view taken along the line A1 - A2 of Fig. 2a. Thereafter, the remaining photoresist thin films were peeled off. The resulting structure was then subjected to a cleaning process. A gold plating process was subsequently conducted for desired portions of the lead frame, that is, regions including inner terminal portions (Fig. 3e).

In the fabrication process of the lead frame, the etching process was conducted with a large etch depth at one major surface of the lead frame blank where outer terminal portions are to be formed, and with a small etch depth at the other major surface of the lead frame. In place of the gold plating, silver or palladium plating may be utilized. The above mentioned lead frame fabrication process is adapted to manufacture a single lead frame required for the manufacture of a single semiconductor device. In terms of productivity, however, the etching process is conducted for lead frame units each corresponding to the single lead frame shown in Fig. 2. To

this end, a frame member (not shown) is provided at a desired portion of the peripheral edge of the lead frame so as to connect a desired part of the outer frame portion 205 shown in Fig. 2 to a corresponding one of an adjacent lead frame.

Using the lead frame fabricated as mentioned above, the resin encapsulated semiconductor device according to the present invention was fabricated. Now, a method for fabricating the resin encapsulated semiconductor device in accordance with an embodiment of the present invention will be described. Fig. 4 illustrates the method for fabricating the resin encapsulated semiconductor device in accordance with the embodiment of the present invention. A polyimide-based thermosetting insulating adhesive (tape) 401 (HM122C manufactured by Hitachi Chemical Co., Ltd.) was applied to one surface, formed with the outer terminal portions 402, of the lead frame 400 fabricated as in Fig. 3 and the outer surface of the lead frame 400 using a hot pressing process conducted at 400 °C and 6 Kg/m<sup>2</sup> for 1.0 second (Fig. 4a). The resulting structure is shown in Fig. 5 which is a plan view. Thereafter, the connecting portions 403 connecting facing tips of the inner terminal portions were punched using punching dies 405A and 405B (Fig. 4b). Also, portions of the insulating adhesive

(tap ) corresponding to those connecting portions 403 were punched (Fig. 4c)

Subsequently, unnecessary portions of the lead frame including the outer frame 404 were cut off using outer frame punching and pressing dies 406A and 406B (Fig. 4d).  
5 The lead frame was then bonded to a semiconductor chip 407 at its leads 410 under pressure while applying heat (Fig. 4e).

The process for cutting off the unnecessary portion of the lead frame including the outer frame 404 supporting  
10 the entire portion of the lead frame along with the connecting lead portion, as shown in Fig. 4d, may be carried out after an resin encapsulating process. In this case, dam bars (not shown) are preferably provided, as in  
15 QFP packages typically using a lead frame having a single layer structure. After the mounting of the leads 410 on the semiconductor chip 411, the inner terminal portion 410 of each lead 410 was electrically connected to an associated one of terminals (pads) 411A of the  
20 semiconductor chip 411 (Fig. 4f).

Subsequently, an epoxy-based resin 415 was molded to encapsulate the resulting structure while exposing the outer terminal portions 410B of the leads 410 using a desired mold (Fig. 4g).

Although specific mold (not shown) was used for the above process in the illustrated case, use of such a die may be unnecessary in so far as the resin encapsulating process can be conducted under the condition in which  
5 desired portions (outer terminal portions) of the lead frame are left. Thereafter, a solder paste was coated on the exposed outer terminal portions 410B in accordance with a screen printing process, thereby forming outer electrodes  
10 416 made of solder (paste). Thus, the fabrication of the resin encapsulated semiconductor device according to the present invention was achieved (Fig. 4h).

Although the formation of the outer electrodes 416 made of solder has been described as being achieved using a screen printing process, it may be achieved using a reflow  
15 or bonding process in so far as an amount of solder required for a connection of the semiconductor device to a circuit board is obtained.

#### (EFFECTS OF THE INVENTION)

20 As apparent from the above description, the present invention makes it possible to increase the occupancy degree of a semiconductor chip in a semiconductor package in situations requiring new resin encapsulated  
25 semiconductor devices having a highly integrated structure while exhibiting a high performance. The present invention



also makes it possible to reduce the area of the semiconductor device on a circuit board in order to cope with a compactness of the semiconductor device. That is, the present invention can provide a semiconductor device  
5 capable of achieving an improvement in the mounting density on a circuit board. At the same time, the present invention can provide a resin encapsulated semiconductor device having a new multipinned structure which could not be realized in compact packages such as conventional TSOPs.